

# (12) UK Patent Application (19) GB (11) 2 396 635 (13) A

(43) Date of A Publication 30.06.2004

(21) Application No: 0329659.7

(22) Date of Filing: 22.12.2003

(30) Priority Data:  
(31) 10328708 (32) 23.12.2002 (33) US

(71) Applicant(s):  
Weatherford/Lamb Inc.  
(Incorporated in USA - Delaware)  
515 Post Oak Boulevard, Suite 600,  
Houston, Texas 77027,  
United States of America

(72) Inventor(s):  
Ken Whanger  
John C Vivic  
Christopher Cuffe  
Clayton Pluchek  
Patrick G Maguire

(74) Agent and/or Address for Service:  
Boulton Wade Tennant  
Verulam Gardens, 70 Gray's Inn Road,  
LONDON, WC1X 8BT, United Kingdom

(51) INT CL<sup>7</sup>:  
E21B 43/10 33/14

(52) UK CL (Edition W):  
E1F FJU FLA

(56) Documents Cited:  
US 4936386 A US 4919989 A  
US 3918523 A

(58) Field of Search:  
UK CL (Edition W) E1F FJU FKA FLA  
INT CL<sup>7</sup> E21B 33/12 33/14 43/10  
Other: EPODOC, WPI, JAPIO

(54) Abstract Title: **Expandable sealing apparatus**

(57) The sealing apparatus 110 includes an expandable tubular body 105 having one or more sealing elements disposed thereon. The sealing elements include swelling 140 and non-swelling 150 sealing elements. The swelling sealing elements are made of a swelling elastomer capable of swelling upon activation by an activating agent. The swelling elements may be covered with a protective layer 145 during the run-in. When the tubular body is expanded, the protective layer breaks, thereby exposing the swelling elements to the activating agent. In turn, the swelling elements swell and contact the wellbore to form a fluid tight seal. The non swelling elements contain the swelling elements to a defined area.

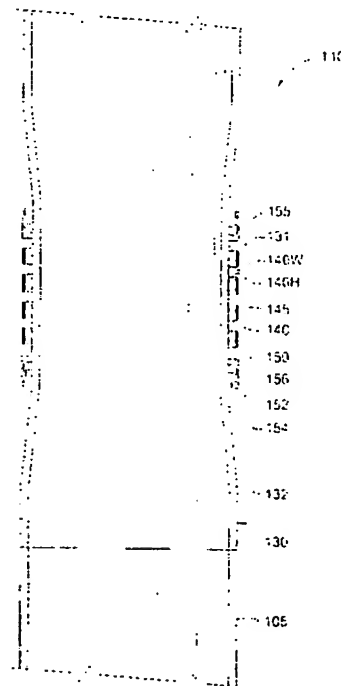


FIG. 4

FIG. 1

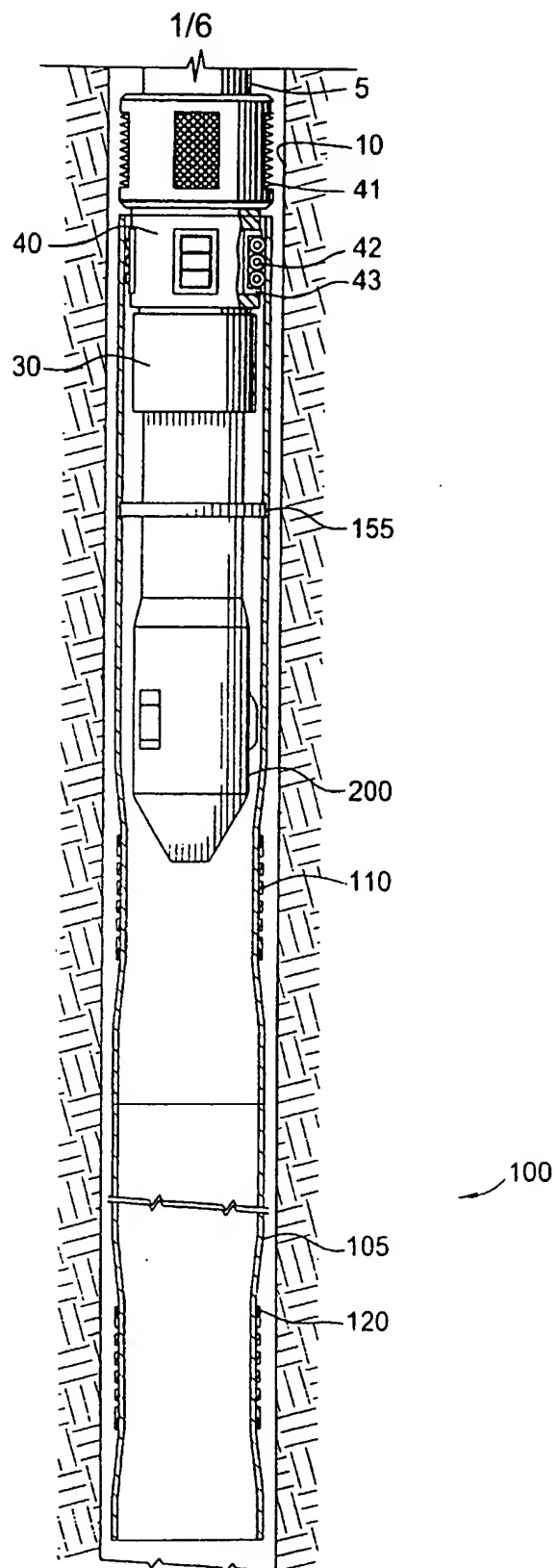


FIG. 2

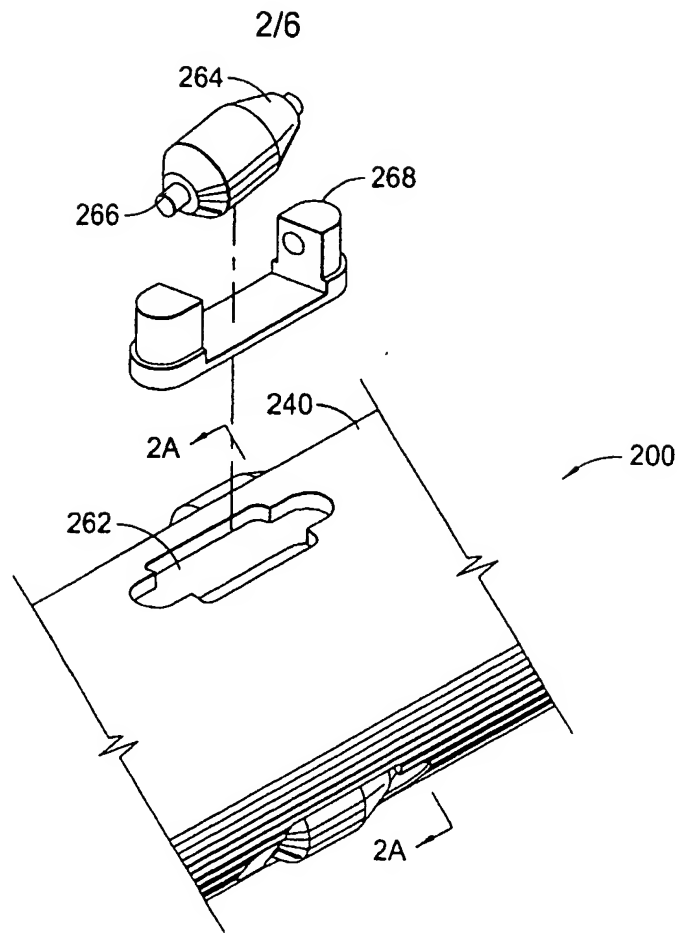
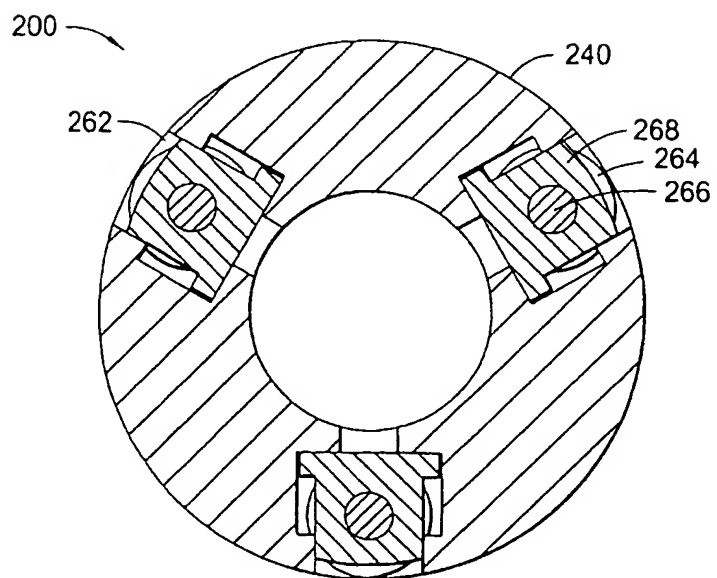


FIG. 2A



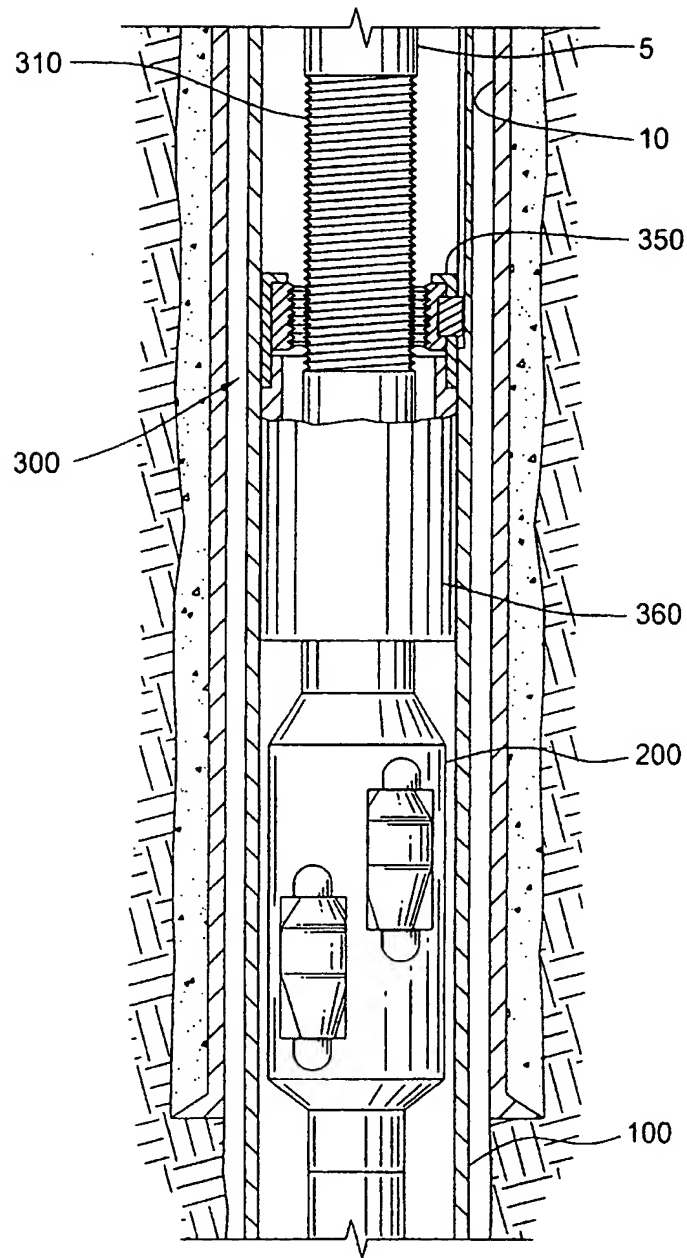


FIG. 3

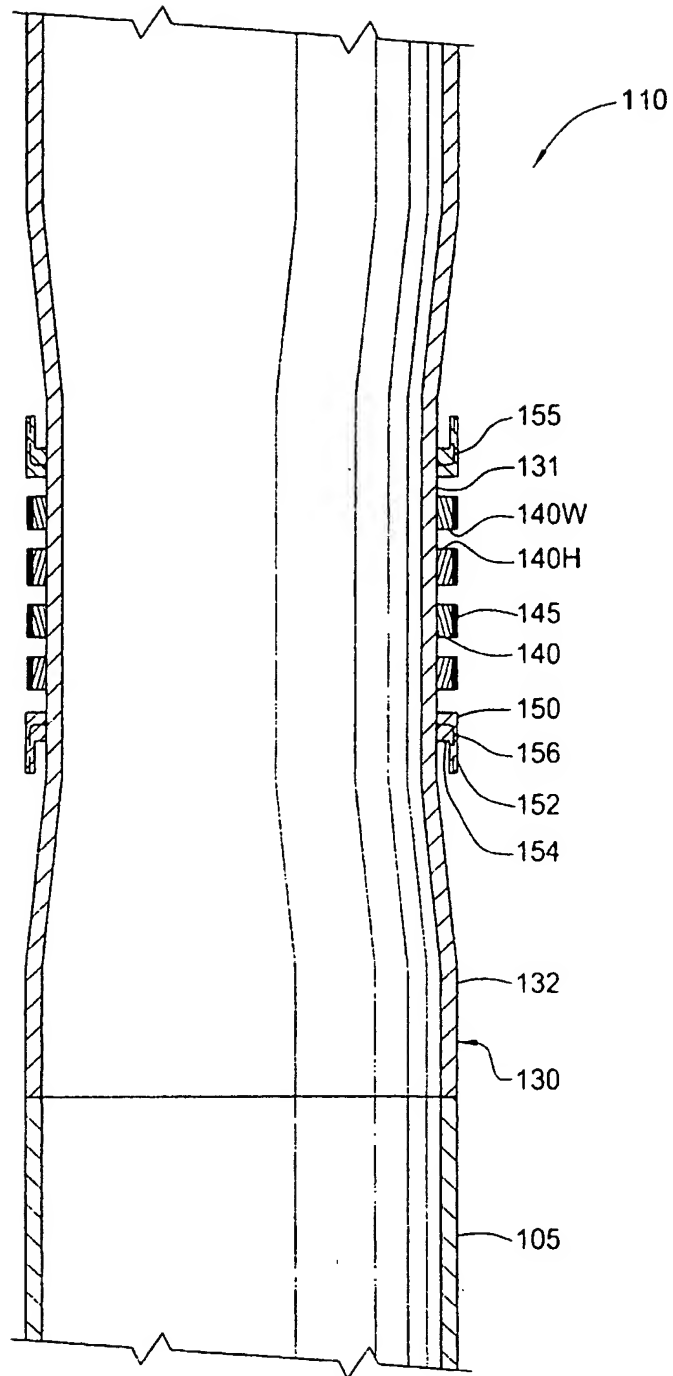


FIG. 4

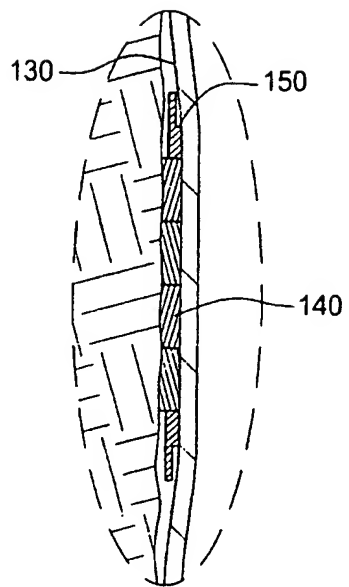


FIG. 5A

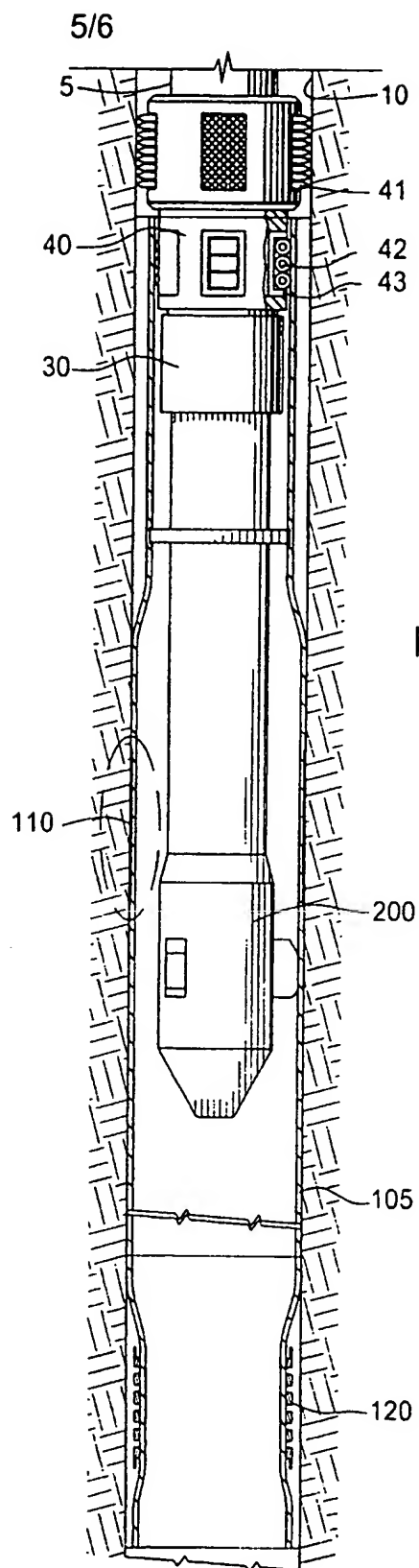


FIG. 5

FIG. 6

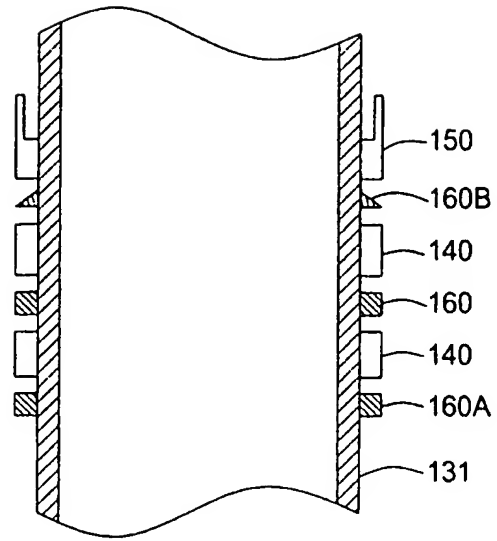
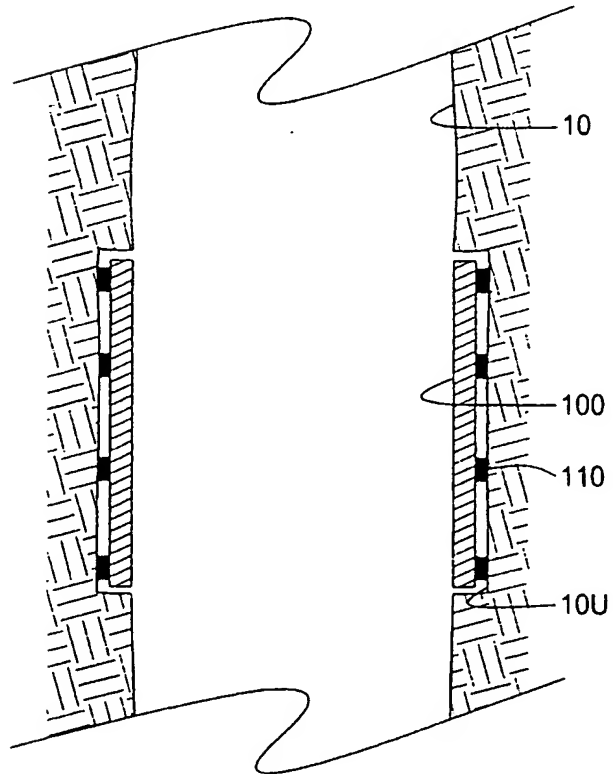


FIG. 7



EXPANDABLE SEALING APPARATUS

The present invention generally relates to a downhole tool for use in a wellbore. More particularly, the invention relates to a downhole tool for isolating a wellbore. More particularly still, the invention relates to an expandable tubular having an expandable or swelling sealing element for isolating a wellbore.

10 In the drilling of oil and gas wells, a wellbore is formed using a drill bit that is urged downwardly at a lower end of a drill string. After drilling a predetermined depth, the drill string and bit are removed, and the wellbore is typically lined with a string of steel pipe  
15 called casing. The casing provides support to the wellbore and facilitates the isolation of certain areas of the wellbore adjacent hydrocarbon bearing formations. The casing typically extends down the wellbore from the surface of the well to a designated depth. An annular area is thus  
20 defined between the outside of the casing and the earth formation. This annular area is filled with cement to permanently set the casing in the wellbore and to facilitate the isolation of production zones and fluids at different depths within the wellbore.

25 Generally, it is desirable to provide a flow path for hydrocarbons from the surrounding formation into the newly formed wellbore. Typically, perforations are formed in the casing at the anticipated depth of hydrocarbons. The  
30 perforations are strategically formed adjacent the hydrocarbon zones to limit the production of water from water rich zones close to the hydrocarbon rich zones.



However, a problem arises when the cement does not adhere to the wellbore properly to provide an effective fluid seal. The ineffective seal allows water to travel along the cement and wellbore interface to the hydrocarbon  
5 rich zone. As a result, water may be produced along with the hydrocarbons.

One attempt to solve this problem is to employ a downhole packer to isolate specific portions of the  
10 wellbore. The downhole packer may be installed as an open-hole completion to isolate a portion of the wellbore and eliminate the need of cementing the annular area between the casing and the wellbore of the isolated portion. Typically, the downhole packer may be formed as an integral member of  
15 the existing casing and installed adjacent the desired production zone.

More recently, expandable tubular technology has been applied to downhole packers. Generally, expandable  
20 technology enables a smaller diameter tubular to pass through a larger diameter tubular, and thereafter expanded to a larger diameter. In this respect, expandable technology permits the formation of a tubular string having a substantially constant inner diameter. Accordingly, an  
25 expandable packer may be lowered into the wellbore and expanded into contact with the wellbore. By adopting the expandable technology, the expandable packer allows a larger diameter production tubing to be used because the conventional packer mandrel and valving system are no longer  
30 necessary.

However, one drawback of the downhole or expandable packers is their lack of gripping members on their outer surfaces. Consequently, the outer surfaces of these conventional packers may be unable to generate sufficient  
5 frictional contact to support their weight in the wellbore. Additionally, the expandable packer may not provide sufficient seal load to effectively seal the annular area between the expanded packer and the wellbore.

10 There is a need, therefore, for a packer having a sealing element that will effectively seal a portion of a tubular or a wellbore. There is a further need for a packer that will not reduce the diameter of the wellbore. Further still, there is a need for a sealing assembly that will  
15 effectively isolate a zone within a tubular or a wellbore.

The present invention generally relates to an apparatus for sealing a wellbore. The sealing apparatus includes an expandable tubular body having one or more sealing elements  
20 disposed thereon. In one aspect, the sealing elements include swelling and non-swelling sealing elements. Preferably, the swelling sealing elements are made of a swelling elastomer capable of swelling upon activation by an activating agent. The swelling elements may be covered with  
25 a protective layer during the run-in. When the tubular body is expanded, the protective layer breaks, thereby exposing the swelling elements to the activating agent. In turn, the swelling elements swell and contact the wellbore to form a fluid tight seal.

30

In another aspect, an apparatus for completing a well is provided. The apparatus includes an expandable tubular

having a first sealing member and a second sealing member. Each sealing member has a tubular body and one or more swelling elements disposed around an outer surface of the tubular body.

5

In another aspect still, the present invention provides a method for completing a well. The method involves running a sealing apparatus into the wellbore. The sealing apparatus includes a tubular body and a swelling element  
10 disposed around an outer surface of the tubular body. The sealing apparatus is expanded to cause the swelling element to swell and contact the wellbore.

So that the manner in which the above recited features  
15 of the present invention, and other features contemplated and claimed herein, are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended  
20 drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

25

Figure 1 is a view of an exemplary sealing assembly according to aspects of the present invention disposed in a wellbore.

30 Figures 2 and 2A are cross-sectional views illustrating an expander tool provided to expand the liner assembly shown in Figure 1.

Figure 3 is a cross-sectional view illustrating a translational tool applicable for axially translating the expander tool in the wellbore.

5        Figure 4 shows an exemplary sealing apparatus according to aspects of the present invention.

Figure 5 is a cross-sectional view illustrating the expander tool expanding the liner assembly according to  
10 aspects of the present invention.

Figure 5A is an enlarged view illustrating the sealing apparatus expanded by the expander tool and the swelling elements activated by the activating agents.

15

Figure 6 illustrates a partial view of an embodiment of the sealing apparatus of the present invention.

Figure 7 illustrates a sealing apparatus installed in  
20 an under-reamed portion of a wellbore.

Figure 1 is a cross-sectional view of a sealing assembly 100 having an expandable tubular body 105, an upper sealing apparatus 110, and a lower sealing apparatus 120  
25 according to aspects of the present invention. The sealing assembly 100 is disposed in an open hole vertical wellbore 10. It should be noted that aspects of the present invention are not limited to an open hole wellbore application, but are equally applicable to a cased wellbore  
30 or a tubular, as well as horizontal and deviated wellbores.

As illustrated in Figure 1, the sealing assembly 100 and an expander tool 200 are lowered into the wellbore 10 on a work string 5. The work string 5 may provide hydraulic fluid from the surface to the expander tool 200 and various components disposed on the work string 5. The work string 5 includes a collet 155 for retaining the sealing assembly 100 during the run-in operation.

A torque anchor 40 may be disposed on the working string 5 to prevent rotation of the sealing assembly 100 during the expansion process. Figure 1 shows the torque anchor 40 in the run-in position. In this view, the torque anchor 40 is in an unactuated position in order to facilitate run-in of the sealing assembly 100 and the expander tool 200. The torque anchor 40 defines a body having one or more sets of slip members 41, 42 radially disposed around its perimeter. In one embodiment, four sets of upper slip members 41 are employed to act against the wellbore 10 and four sets of lower slip members 42 are employed to act against the sealing assembly 100. Preferably, the upper slip members 41 have teeth-like gripping members disposed on an outer surface, while the lower slip members 42 have one or more wheels designed with sharp edges (not shown) to prevent rotational movement of the torque anchor 40. Although wheels and teeth-like slip mechanisms 42, 41 are presented in the Figure 1, other types of slip mechanisms may be employed with the torque anchor 40 without deviating from the aspects of the present invention.

The torque anchor 40 is run into the wellbore 10 on the working string 5 along with the expander tool 200 and the sealing assembly 100. In the run-in position, the slip

members 41, 42 are retracted within the housing 43, because the sealing assembly 100 is retained by the collet 155. Once the sealing assembly 100 has been lowered to the appropriate depth within the wellbore 10, the torque anchor 40 is activated. Fluid pressure provided from the surface through the working string 5 forces the upper and lower slip members 41, 42 outward from the torque anchor body 40. The upper slip members 41 act against the inner surface of the wellbore 10, thereby placing the torque anchor 40 in frictional contact with the wellbore 10. Similarly, the lower slip members 42 act against an inner surface of the sealing assembly 100, thereby placing the torque anchor 40 in frictional contact with the sealing assembly 100. This activated position is depicted in Figure 5. In the activated position, the torque anchor 40 is rotationally fixed relative to the wellbore 10.

As shown in Figure 1, an expander tool 200 provided to expand the sealing assembly 100 is disposed on the working string 5. The expander tool 200 may be operatively coupled to a motor 30 to provide rotational movement to the expander tool 200. The motor 30 is disposed on the work string 5 and may be hydraulically actuated by a fluid medium being pumped through the work string 5. The motor 30 may be a positive displacement motor or other types of motor known in the art. Although a rotary expander tool 200 is disclosed herein, other types of expander tools such as a cone-shaped mandrel are also applicable according aspects of the present invention.

30

Figure 2 is a sectional view of an exemplary expander tool 200. Figure 2A presents the same expander tool 200 in

cross-section, with the view taken across line 2A-2A of Figure 2.

As illustrated in Figure 2, the expander tool 200 has a  
5 central body 240 which is hollow and generally tubular. The  
central body 240 has a plurality of windows 262 to hold a  
respective roller 264. Each of the windows 262 has parallel  
sides and holds a roller 264 capable of extending radially  
from the expander tool 200. Each of the rollers 264 is  
10 supported by a shaft 266 at each end of the respective  
roller 264 for rotation about a respective rotational axis.  
Each shaft 266 is formed integral to its corresponding  
roller 264 and is capable of rotating within a corresponding  
piston 268. The pistons 268 are radially slidable, each  
15 being slidably sealed within its respective radially  
extended window 262. The back side of each piston 268 is  
exposed to the pressure of fluid within the annular space  
between the expander tool 200 and the work string 5. In  
this manner, pressurized fluid supplied to the expander tool  
20 200 may actuate the pistons 268 and cause them to extend  
outwardly into contact with the inner surface of the sealing  
assembly 100. Additionally, the expansion tool 200 may be  
equipped with a cutting tool (not shown) to cut the sealing  
assembly 100 at a predetermined location. The cutting tool  
25 may be used to release the expanded portion of the sealing  
assembly 100 from the torque anchor 40 so that the work  
string 5 and the expander tool 200 may be removed from the  
wellbore 10 after expansion is completed.

30 The expander tool 200 may include an apparatus for  
axially translating the expander tool 200 relative to the  
sealing assembly 100. One exemplary apparatus 300 for

translating the expander tool 200 is disclosed in U.S. Patent Application Serial No. 10/034,592, filed on December 28, 2001, which application is herein incorporated by reference in its entirety. In one aspect, the translating apparatus 300 includes helical threads 310 formed on the work string 5 as illustrated in Figure 3. The expander tool 200 may be operatively connected to a nut member 350 which rides along the threads 310 of the work string 5 when the work string 5 is rotated. The expander tool 200 may further include a recess 360 connected to the nut member 350 for receiving the work string 5 as the nut member 350 travels axially along the work string 5. The expander tool 200 is connected to the nut member 350 in a manner such that translation of the nut member 350 along the work string 5 serves to translate the expander tool 200 axially within the wellbore 10.

In one embodiment, the motor 30 illustrated in Figure 1 may be used to rotate the work string 5. The work string 5 may further include one or more swivels (not shown) to permit the rotation of the expander tool 200 without rotating other tools downhole. The swivel may be provided as a separate downhole tool or incorporated into the expander tool 200 using a bearing-type connection (not shown).

The sealing assembly 100 shown in Figure 1 may be expanded to isolate a portion of the wellbore 10. The sealing assembly 100 may include an expandable tubular 105 disposed between an upper sealing apparatus 110 and a lower sealing apparatus 120. Examples of the expandable tubular 105 include expandable solid tubulars, expandable slotted



tubulars, expandable screens, and other forms of expandable tubulars known to a person of ordinary skill in the art. Further, the expandable tubular 105 may include one or more tubulars connected end to end. Isolation of the wellbore 10  
5 may have applications such as shutting off production from a formation or preventing loss of fluid in the wellbore 10 to the formation. Moreover, the expandable tubular 105 may include an expandable screen to filter formation fluids entering the wellbore 10.

10

As shown, each sealing apparatus 110, 120 is connected to one end of the expandable liner 105. In this respect, the sealing apparatus 110, 120 are designed as separate components that may be easily attached to an expandable  
15 tubular 105 as needed. However, it must be noted that the sealing apparatus 110, 120 may also be formed directly on the expandable tubular 105 without deviating from the aspects of the present invention. Although only two sealing apparatus are described in the present embodiment, aspects  
20 of the present invention are equally applicable with one or more sealing apparatus. In the embodiment shown, the upper sealing apparatus 110 and the lower sealing apparatus 120 are substantially similar and interchangeable. Therefore, the upper sealing apparatus 110 will be described below as  
25 the description relating to the upper sealing apparatus 110 is also applicable to the lower sealing apparatus 120.

Figure 4 illustrates an exemplary sealing apparatus 110 according to aspects of the present invention. The sealing  
30 apparatus 110 includes a tubular body 130 having one or more sealing elements 140, 150 disposed around an outer portion 131 of the tubular body 130. Preferably, the sealing

elements 140, 150 are disposed on a recessed outer portion 131 having a smaller outer diameter than a non-recessed portion 132 of the tubular body 130. In one embodiment, the combined outer diameter of the recessed portion 131 and the  
5 sealing elements 140, 150 is the same or less than the outer diameter of the non-recessed portion 132 of the tubular body 130. In this respect, the sealing elements 140, 150 may be disposed in the recessed portion 131 without substantially affecting the clearance required to move the sealing  
10 assembly 100 within the wellbore 10. In this manner, the outer diameter of the expandable sealing assembly 100 may be maximized, which, in turn, minimizes the amount of expansion necessary to install the expandable liner 105 in the wellbore.

15

The sealing elements used to isolate the wellbore 10 may include swelling sealing elements 140 and non-swelling sealing elements 150. In one embodiment, the swelling sealing elements 140 are made of a swelling elastomer that  
20 increases in size upon activation by an activating agent. Depending on the application, swelling elastomers may be selected to activate upon exposure to an activating agent such as a wellbore fluid, hydrocarbons, water, drilling fluids, non-hydrocarbons, and combinations thereof. An  
25 example of a swelling elastomer activated by hydrocarbons is neoprene. Examples of swelling elastomers activated by water include, but not limited to, nitrile and hydrogenated nitrile. Without limiting the aspects of the present invention to a certain activating mechanism, it has been  
30 found that activation occurs by way of absorption of the activating agent by the swelling elastomers. In turn, the absorption causes the polymer chains of the swelling

elastomers to swell radially and axially. It must be noted that different types of swelling elastomers activated by other forms of activating agents are equally applicable without departing from the aspects of the present invention.

5 Further, swelling elastomers described herein as being hydrocarbon activated or water activated are not limited to elastomers activated solely by hydrocarbon or water, but may encompass elastomers that exhibit a faster swelling rate for one activating agent than another activating agent. For  
10 example, swelling elastomers classified as hydrocarbon activated may include elastomers activated by either hydrocarbon or water. However, the hydrocarbon activated swelling elastomer display a faster swelling rate when exposed to hydrocarbon than water.

15

The swelling elements 140 may be disposed on the tubular body 130 in many different arrangements. Preferably, multiple rings of swelling elements 140 are arranged around the recessed portion 131. However, a single  
20 ring of swelling element 140 is also contemplated. In one embodiment, alternate rings of hydrocarbon activated swelling elements 140H and water activated swelling elements 140W are disposed on the tubular body 130 as illustrated in Figure 4. To accommodate the swelling upon activation, each  
25 swelling element 140 may be spaced apart from an adjacent swelling element 140. The distance between adjacent elements 140 may be determined from the extent of anticipated swelling. In another embodiment, the swelling elements 140 may include only hydrocarbon activated swelling  
30 elastomers 140H or water activated swelling elastomers 140W. In another embodiment still, each element may include alternate layers of hydrocarbon 140H or water 140W activated

swelling elastomers. For example, a layer of hydrocarbon activated swelling elastomers 140H may be disposed on top of a layer of water activated swelling elastomers 140W. The upper layer of swelling elastomers 140H may include pores or  
5 ports for fluid communication between the lower layer of swelling elastomers 140W and the activating agent.

The swelling elements 140 may be covered with a protective layer 145 to avoid premature swelling prior to  
10 reaching the desired location in the wellbore 10. Preferably, the protective layer 145 is made of a material that does not swell substantially upon contact with the activating agent. Further, the protective layer 145 should be strong enough to avoid tearing or damage as the sealing  
15 assembly 100 is run-in the wellbore 10. On the other hand, the protective layer 145 should break or tear upon expansion of the sealing apparatus 110, 120 by the expander tool 200 in order to expose the swelling elastomers 140 to the activating agent. In one embodiment, the protective layer  
20 145 may include mylar, plastic, or other material having the desired qualities of the protective layer 145 as disclosed herein.

Non-swelling sealing elements 150 may be placed at each  
25 end of the swelling sealing elements 140 to contain and control the direction of swelling. In one embodiment, the non-swelling sealing elements 150 include a pair of non-swelling lip seals 150 as illustrated in Figure 4. Preferably, the non-swelling lip seals 150 are made of an  
30 elastomeric material. The lip seals 150 include a flexible member 152 extending from the base portion 154 of the lip seal 150 and parallel to the body 130 of the sealing

apparatus 110. The flexible member 152 may bend away from the sealing apparatus 110 toward the wellbore 10 when it encounters a force coming from the distal end of the flexible member 152. The flexible member 152 may provide  
5 additional seal load for the sealing apparatus 110 when it is actuated.

In another aspect, the non-swelling nature of the base portion 154 of the lip seal 150 serves to control the  
10 direction of expansion of the swelling elements 140. In this respect, the swelling elements 140 are allowed to expand axially relative to the wellbore 10 until they encounter the base portion 154. As such, the base portion 154 acts as barriers to axial expansion and limits further  
15 axial swelling of the swelling elements 140. As a result, the swelling elements 140 are limited to swelling radially toward the wellbore 10. In this manner, a substantial amount of swelling is directed toward the wellbore 10, thereby creating a fluid tight seal between the wellbore 10  
20 and the sealing apparatus 110. Although a single directional lip seal 152 is disclosed herein, aspects of the present invention also contemplate the use of non-swelling elements 150 having no lip seals or a bi-directional lip seal.

25

In another aspect, the non-swelling elements 150 may include a reinforcement sheath 155 embedded therein. The reinforcement sheath 155 provides additional support to the flexible member 152 so that it may withstand stronger forces  
30 encountered in the wellbore 10. Preferably, the reinforcement sheath 155 is made of a thin, flexible, and strong material. Examples of the reinforcement sheath 155

include wire mesh, wire cloth, cotton weave, polyester, kevlar, nylon, steel, composite, fiberglass, and other thin, flexible, and other materials as is known to a person of ordinary skill in the art. In another embodiment, the  
5 reinforcement sheath 155 may be wrapped around a portion of the non-swelling elements 150.

In another aspect still, backup rings 160 may be disposed between the swelling sealing elements 150 to  
10 contain and control the direction of swelling as illustrated in Figure 6. Figure 6 is a partial view of the sealing apparatus 110 of the present invention. As shown, a backup ring 160 may be formed on each side of a swelling sealing element 150. Backup rings 160A and 160B illustrate two  
15 examples of the shapes in which the backup rings 160 may embody.

In operation, the sealing assembly 100 is lowered into the wellbore 10 and positioned adjacent the area of the  
20 wellbore 10 to be sealed off as illustrated in Figure 1. Once in position, the torque anchor 40 is actuated to ensure the sealing assembly 100 does not rotate during the expansion operation. Thereafter, pressure is supplied to the expander tool 200 to extend the rollers 264 into contact  
25 with the inner surface of the sealing assembly 100. The pressure also actuates the motor 30, which begins rotating the expander tool 200 relative the sealing assembly 100. The combined actions of the roller extension and rotation plastically deform the sealing assembly 100 into a state of  
30 permanent expansion.

As the expander tool 200 translates axially along the sealing assembly 100, the recessed portion 131 and the non-recessed portion 132 of the sealing apparatus 110 are expanded to the same or substantially the same inner diameter as shown in Figure 5. The expansion of the recessed portion 131 also expands the sealing elements 140, 150 disposed on the sealing apparatus 110. The expansion causes the protective layer 145 around the swelling sealing elements 140 to break, thereby exposing the swelling sealing elements 140 to the activating agents. As shown, the swelling sealing elements 140 include both hydrocarbon activated and water activated swelling elements 140H, 140W. The respective sealing elements 140H, 140W are activated by the hydrocarbon and water found in the wellbore 10. Once activated, the swelling elements 140 swell in both the radial and axial direction. However, axial swelling is limited by adjacent swelling elements 140 or the non-swelling elements 150. In this manner, a substantial amount of the swelling may be directed toward the wellbore 10 to create a strong, fluid tight seal.

Figure 5A is an exploded view of the recess portion 131 of the sealing apparatus 110 expanded in the wellbore 10. As shown, the swelling elements 140 have been activated to seal off the annular space between the wellbore 10 and the sealing assembly 100. It can also be seen that an increase in pressure in the wellbore 10 will cause the flexible portion 152 of the non-swelling elements 150 to bend toward the wellbore 10 to provide additional seal load to seal the wellbore 10.

After the sealing apparatus 110 has been expanded, the collet and the torque anchor 40 may be de-actuated, thereby releasing the expander tool 200 from the sealing assembly 100. In this respect, the expander tool 200 is free to move  
5 axially relative to the sealing assembly 100. The expander tool 200 may now be rotated by rotating the work string 5. The expansion process continues by moving the expander tool 200 axially toward the unexpanded portions of the sealing assembly 100. After the sealing assembly 100 has been fully  
10 expanded, the expander tool 200 is de-actuated and removed from the wellbore 10.

In another embodiment (not shown), the sealing assembly 100 may be expanded in sections. After the upper sealing  
15 apparatus 110 is expanded. The unexpanded portion of the sealing assembly 100 above the upper sealing apparatus 110 may be severed from the remaining portions of the sealing assembly 100. Thereafter, the torque anchor 40 may be de-actuated to free the expander tool 200. The expanded upper  
20 sealing apparatus 110 now serves to hold the sealing assembly 100 in the wellbore 10, thereby allowing the work string 5 to move axially in the wellbore 10. The work string 5 may now reposition itself in the wellbore 10 so that the expander tool 200 may expand the next section of  
25 the sealing assembly 100.

In another aspect, the sealing assembly 100 may be disposed in an under-reamed portion 10U of the wellbore 10 as illustrated in Figure 7. Initially, a portion 10U of the  
30 wellbore 10 may be under-reamed to increase its inner diameter. The wellbore 10 may be under-reamed in any manner known to a person of ordinary skill in the art. Thereafter,



the sealing assembly 100 may be expanded in the under-reamed portion 10U of the wellbore 10. An advantage to such an application is that the inner diameter of the sealing assembly 100 after expansion may be substantially equal to  
5 the initial inner diameter of the wellbore 10. As a result, the installation of the sealing assembly 100 will not affect the inner diameter of the wellbore 10.

Figure 7 also shows the sealing assembly 100 having  
10 four sealing apparatus 110. As discussed earlier, the sealing assembly 100 may be equipped with any number of sealing apparatus 110 without deviating from the aspects of the present invention.

15

20

25

CLAIMS

1. A sealing apparatus for isolating a tubular,  
5 comprising:  
    a tubular body;  
    one or more swelling elastomers disposed around an  
    outer surface of the tubular body; and  
    a cover at least partially disposed on a portion of the one  
10 or more swelling elastomers.
2. The apparatus of claim 1, wherein the one or more  
swelling elastomers are disposed on a recessed portion of  
the outer surface of the tubular body.  
15
3. The apparatus of claim 1 or claim 2, further comprising  
at least one non-swelling member disposed adjacent each end  
of the one or more swelling elastomers.
- 20 4. The apparatus of claim 3, wherein the one or more  
swelling elastomers and the at least one non-swelling member  
are disposed on a recessed portion of the outer surface of  
the tubular body.
- 25 5. The apparatus of claim 3 or claim 4, wherein the at  
least one non-swelling member includes a reinforcement  
sheath.
6. The apparatus of any preceding claim, wherein the one  
30 or more swelling elastomers are activated by a wellbore  
fluid.

7. The apparatus of claim 6, wherein the wellbore fluid is selected from the group consisting of water, hydrocarbon, and combinations thereof.

5 8. The apparatus of any preceding claim, wherein expanding the tubular body causes the cover to become more permeable to an activating agent.

9. The apparatus of any preceding claim, wherein the one  
10 or more swelling elastomers include at least one hydrocarbon activated swelling elastomer and at least one water activated swelling elastomer.

10. The apparatus of any preceding claim, wherein the  
15 tubular body comprises an expandable tubular body.

11. The apparatus of any preceding claim, wherein the cover substantially prevents the one or more swelling elastomers from activating.

20

12. An apparatus for isolating a well, comprising:  
an expandable tubular having a first sealing member and a second sealing member, wherein each of the sealing members include:

25

a tubular body; and  
one or more swelling elements disposed around an outer surface of the tubular body.

13. The apparatus of claim 12, further comprising a  
30 protective layer disposed around the one or more swelling elements.

14. The apparatus of claim 13, wherein the cover substantially prevents the one or more swelling elastomers from activating.
- 5 15. The apparatus of claim 14, wherein expanding the tubular body causes the cover to become more permeable to an activating agent.
- 10 16. The apparatus of any of claims 12 to 15, wherein the one or more swelling elements are disposed on a recessed portion of the outer surface of the tubular body.
- 15 17. The apparatus of any of claims 12 to 16, further comprising at least one non-swelling element disposed adjacent each end of the one or more swelling elements.
- 20 18. The apparatus of claim 17, wherein the one or more swelling elements and the at least one non-swelling element are disposed on a recessed portion of the outer surface of the tubular body.
- 25 19. The apparatus of any of claims 12 to 18, wherein the one or more swelling elements are activated by an agent selected from the group consisting of water, hydrocarbon, and combinations thereof.
20. A method for isolating a well, comprising:  
    running a sealing apparatus into the wellbore, the sealing apparatus including:  
30 a tubular body; and  
    a swelling element disposed around an outer surface of the tubular body;

expanding the tubular body; and  
causing the swelling element to swell and contact the  
wellbore.

5 21. The method of claim 20, wherein the sealing apparatus  
further comprises a protective cover at least partially  
disposed on a portion of the swelling element.

22. The method of claim 21, wherein expanding the tubular  
10 body causes the protective cover to become more permeable to  
an activating agent.

23. The method of any of claims 20 to 22, wherein the  
sealing apparatus further comprises a non-swelling element  
15 dispose adjacent to the swelling element.

24. The method of claim 23, wherein the non-swelling  
element includes a reinforcement sheath.

20 25. The method of any of claims 20 to 24, wherein the  
tubular body comprises an expandable tubular.

26. The method of any of claims 20 to 25, further  
comprising exposing the swelling element to an activating  
25 agent.

27. The method of claim 26, wherein the swelling element  
comprises an elastomer.

30 28. The method of any of claims 20 to 27, wherein the  
swelling element swells when exposed to an activating agent.



Application No: GB 0329659.7  
Claims searched: 1-28

Examiner: R L Williams  
Date of search: 26 February 2004

## Patents Act 1977 : Search Report under Section 17

### Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1,6,7,12-14,19-21,28	US 4,936,386	R V Colangelo
X	1,6,7,12-14,19-21,28	US 4,919,989	R V Colangelo
X	1,6,7,12-14,19-21,28	US 3,918,523	I L Stuber

### Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

### Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>w</sup>:

E1F

Worldwide search of patent documents classified in the following areas of the IPC<sup>?</sup>:

E21B

The following online and other databases have been used in the preparation of this search report:

EPODOC,WPI,JAPIO

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☒ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKewed/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☒ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**